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Indian Standard

**SPECIFICATION FOR
STEEL FOR THE MANUFACTURE OF VOLUTE
HELICAL AND LAMINATED SPRINGS FOR
AUTOMOTIVE SUSPENSION**

(*Second Revision*)

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**BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002**

Indian Standard

SPECIFICATION FOR STEEL FOR THE MANUFACTURE OF VOLUTE, HELICAL AND LAMINATED SPRINGS FOR AUTOMOTIVE SUSPENSION

(*Second Revision*)

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Indian Standard

SPECIFICATION FOR STEEL FOR THE MANUFACTURE OF VOLUTE, HELICAL AND LAMINATED SPRINGS FOR AUTOMOTIVE SUSPENSION

(Second Revision)

0. FOREWORD

0.1 This Indian Standard (Second Revision) was adopted by the Indian Standards Institution on 25 November 1982 after the draft finalized by Wrought Steel Products Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 This standard was first published in 1965 and was revised in 1975. While reviewing the standard, in the light of the experience gained during subsequent years, the committee decided to revise the standard incorporating the following main modifications:

- i) Amendment No. 1 issued earlier has been incorporated.
- ii) One more grade of steel has been specified,
- iii) Requirements for mode of delivery hardenability, cold shearability and surface decarburization has been specified.
- iv) Clause on retest has been deleted as it is duly covered in IS : 8910-1978*.

0.3 In the preparation of this standard considerable assistance has been derived from DIN 1722-1972 'Hot rolled steels for quenched and tempered springs — Quality specifications', issued by Deutsches Institut für Normung (DIN).

0.4 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained

*General technical delivery requirements for steel and steel products.

†Rules for rounding off numerical values (revised).

in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard covers the requirements for hot-rolled (as centreless ground or precision bar) steel in the form of bars and flats for the manufacture of volute, helical and laminated springs for automotive suspension.

2. GRADES

2.1 Steel shall be of five grades as specified in Table 1.

3. SUPPLY OF MATERIAL

3.1 General requirements relating to supply of material shall conform to IS : 8910-1978*.

4. MANUFACTURE

4.1 Steel shall be made by the open-hearth, electric or a combination of these processes. In case any other process is employed by the manufacturer, prior approval of the purchaser shall be obtained.

4.2 The size of ingots, billets or continuous cast billets for any given size of finished steel product shall be such that a minimum reduction ratio of 16 : 1 from the minimum cross sectional area of the ingot or continuous cast billets to the maximum cross sectional area of the product is ensured. However, reduction ratio other than that specified may be agreed subject to mutual agreement between the purchaser and the manufacturer.

5. CHEMICAL COMPOSITION

5.1 The ladle analysis of the material, when carried out by the method specified in the relevant parts of IS : 228† or any other established instrumental/chemical method, shall be as given in Table 1. In case of dispute, the procedure given in relevant parts of IS : 228† shall be the referee method. However, where the method is not given in IS : 228† and its relevant parts, the referee method shall be as agreed to between the purchaser and the manufacturer.

*General technical delivery requirements for steel and steel products.

†Methods of chemical analysis of steel (issued in several parts).

TABLE 1 CHEMICAL COMPOSITION

(Clauses 2.1 and 5.1)

Sl No	GRADE DESIG- NATION [see IS : 1762 (Part 1)-1974*]	CONSTITUENTS, PERCENT						
		Car- bon	Sili- con	Manga- nese	Sul- phur Max	Phos- phorus Max	Chro- mium	Vana- dium
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
i)	55Si7	0.50- to 0.60	1.50 to 2.00	0.80 to 1.00	0.045	0.045	—	—
ii)	60Si7	0.55 to 0.65	1.50 to 2.00	0.80 to 1.00	0.045	0.045	—	—
iii)	65Si7	0.60 to 0.70	1.50 to 2.00	0.80 to 1.00	0.045	0.045	—	—
iv)	50Cr4V2	0.45 to 0.55	0.15 to 0.35	0.50 to 0.80	0.045	0.045	0.90 to 1.20	0.15 to 0.30
v)	60Cr4V2	0.55 to 0.65	0.15 to 0.35	0.80 to 1.00	0.045	0.045	0.90 to 1.20	0.15 Min

NOTE — In case of Grade 55Si7, for the bars of sizes 26 mm, and above, carbon content shall be as 0.55 percent *Min*.

*Code for designation of steels: Part I Based on letter symbols (*first revision*).

5.2 Product Analysis — The permissible variation in the case of product analysis, from the limits specified in Table 1 shall be as follows:

Constituent	Permissible Variation Over Specified Limit, Percent
Carbon	± 0.03
Manganese	± 0.04
Silicon	± 0.03
Sulphur	± 0.005
Phosphorus	± 0.005
Chromium	± 0.03
Vanadium	± 0.02

NOTE — Variations shall not be applicable both over and under the specified limits in several determinations in a heat.

6. MODES OF DELIVERY (GUARANTEE COVERAGE)

6.1 Steels according to this standard shall be supplied in one of the modes of delivery (combination of guaranteed properties) according to Table 2.

TABLE 2 GUARANTEE COVERAGE AND SYMBOLS FOR MODES OF DELIVERY

(*Clauses 6.1 and 9.2*)

Sl No.	GUARANTEE (<i>see</i> NOTE 2)	GUARANTEE COVERAGE AND SYMBOLS FOR MODE OF DELIVERY (<i>see</i> NOTE 3)					
		1	1a	3	3a	11l	11k
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	Chemical composition	x	x	x	x	x	x
ii)	Hardness in the core after quenching (<i>see</i> NOTE 4)	x	x	x	x	x	x
iii)	Hardness in the soft annealed condition (G)		x		x		
iv)	Cold shearability (C)					x	x
v)	Mechanical properties in the quenched and tempered condition determined from the reference specimen (<i>see</i> NOTE 5)			x	x		x

NOTE 1 — The horizontal crosses (x) appearing in each column denote the guarantee coverage of the mode of delivery concerned, for which the symbol is listed in the column headings.

NOTE 2 — The code letters for the treatment condition are given in brackets.

NOTE 3 — The numbers and letters are largely in agreement with the identifications used in the international standards.

NOTE 4 — *See* 7.1 and Table 3.

NOTE 5 — *See* 8 and Table 4.

Examples of application:

- When the order specifies the mode of delivery by quoting the symbol 1a, chemical composition from the product analysis, hardness in the core after quenching and maximum hardness in the soft annealed condition shall be guaranteed.
- If the chemical composition according to the ladle analysis, the hardness in the core after quenching and the mechanical properties in the quenched and tempered condition as determined from the reference specimen are to be guaranteed, the mode of delivery shall be stated in the order by quoting the symbol 3.

6.1.1 The treatment condition and the mode of delivery (*see* Table 2) shall be specified when ordering. Delivery is usually made in the untreated (hot rolled) condition with guarantee of the chemical composition and through-hardenability (hardness in the core after quenching).

6.2 The surface of the material may be coated with a thin layer of antirust oil, when agreed to between the purchaser and the supplier.

7. HARDENABILITY

7.1 For the steels according to this standard through-hardenability is guaranteed for round and rectangular cross-sections up to the maximum dimensions indicated in Table 3.

TABLE 3 LIMITING DIMENSIONS FOR THROUGH HARDENABILITY OF THE STEEL

STEEL GRADE	MINIMUM VALUE OF HARDNESS IN THE CORE AFTER QUENCHING* HRC	HARDENING IN*	MAXIMUM DIMENSIONS FOR	
			Flat Products (Thickness) mm	Round Steel (Diameter) mm
(1)	(2)	(3)	(4)	(5)
55Si7	54	Oil	16	20
60Si7	54	Oil	16	20
65Si7	54	Oil	16	25
50Cr4V2	54	Oil	16	25
60Cr4V2	54	Oil	25	40

*Valid for the quenching temperature of 830-860°C.

7.1.1 Full through-hardening is denoted by a minimum hardness value of 54 HRC.

7.1.2 Through hardenability is verified only if specially specified while ordering.

8. MECHANICAL PROPERTIES

8.1 The data quoted in Table 2 for hardness in the untreated (hot-rolled) condition are reference values and are not binding.

8.2 In the case of modes of delivery 1a and 3a the maximum hardness values in the soft annealed condition according to Table 4 shall be guaranteed.

TABLE 4 MECHANICAL PROPERTIES

STEEL GRADE	UNTREA- TED (HARD- NESS) HB	TREATMENT CONDITION			ELONGATION PERCENT GAUGE LENGTH $5.65\sqrt{S_0}$ Min
		Soft Annealed (Hardness) HB	Quenched and Tempered		
			Yield Stress MPa <i>Min</i>	Tensile Strength MPa	
(1)	(2)	(3)	(4)	(5)	(6)
55Si7	≈ 270	245	1 130	1 320 to 1 570	6
60Si7	≈ 310	255	1 130	1 320 to 1 570	6
65Si7	≈ 310	255	1 180	1 370 to 1 620	6
50Cr4V2	> 310	245	1 180	1 370 to 1 620	6
60Cr4V2	> 310	255	1 180	1 370 to 1 620	6

8.3 In case of modes of delivery 3, 3a and 11k, the mechanical properties according to Table 4 shall be guaranteed for the quenched and tempered conditions. The values shall be verified on specimens with a diameter of 10 mm which shall be taken from the core of product in the rolling direction and shall be quenched at 830 to 860°C and tempered at 350° to 550°C. If such a specimen with 10 mm diameter can not be prepared from the product, its diameter shall be the largest value possible as determined by the size ordered.

9. COLD SHEARABILITY

9.1 If, so ordered (see Table 2), all the steels according to this standard are available with guaranteed cold shearability. Ordering in this way is recommended for steels which may exhibit a hardness of more than 280 HB in the as-rolled condition and for which processing by cold shearing is envisaged.

10. FREEDOM FROM DEFECTS

10.1 Material shall be free from harmful defects, such as, pipe, heavy scale, rust, blisters, laminations, cracked edges and seams and/or other rolling defects, which can impair the durability of the springs.

10.2 Flats shall be usually supplied with round edges. The edges shall be rolled convex with a radius of curvature approximately equal to the thickness of the flat or as agreed to between the purchaser and the supplier.

10.3 If, in view of the importance of the surface condition in terms of fatigue strength, particularly for springs subject to torsional stress, round

steel is specified in the centreless turned or ground condition, special agreement for the same shall be reached when ordering the steel.

10.4 If, so desired by the purchaser, the material shall be tested for inclusion rating as per IS : 4163-1982* and the acceptance limit shall be as agreed mutually.

11. SURFACE DECARBURISATION

11.1 Decarburisation shall be kept at minimum. A limit of decarburisation may be fixed by agreement between the purchaser and the supplier.

12. STRAIGHTNESS

12.1 Bars and flats shall be reasonably straight. Unless otherwise agreed to between the purchaser and the supplier, out-of-straightness to the extent of 2 mm per metre length shall be acceptable.

13. DIMENSIONS AND TOLERANCES

13.1 Dimensions of bars and flats shall be as specified by the purchaser.

13.2 Rolling tolerances on diameter of bars shall be as specified in Table 5.

TABLE 5 ROLLING TOLERANCES FOR ROUND SECTIONS

NOMINAL DIAMETER mm	TOLERANCE mm	'OUT OF ROUND' TOLER- ANCE, Max mm
(1)	(2)	(3)
5 to 25	± 0.20	0.25
Over 25 up to 50	± 0.35	0.50

13.3 For centreless ground and precision hot-rolled bars, the tolerances shall be as follows:

Type of Bar	Tolerance on Diameter mm
Centreless ground bars	± 0.05
Precision hot-rolled bars:	
a) Below 10 mm dia	± 0.10
b) 10 mm dia up to 25 mm dia	± 0.15
c) Over 25 mm dia	± 0.20

*Method for determination of inclusion content in steel by microscopic method (first revision).

13.4 Rolling tolerances on width, thickness, flatness and concavity of flats shall be as specified in Table 6.

TABLE 6 ROLLING TOLERANCES FOR FLAT SECTIONS

All dimensions in millimetres.

NOMINAL WIDTH	TOLERANCE ON WIDTH	TOLERANCE ON THICKNESS*		CONCAVITY + Max	
		Up to and Including 10 mm	Over 10 mm	For Thickness up to and Including 10 mm	For Thickness over 10 mm
(1)	(2)	(3)	(4)	(5)	(6)
40 up to 50	± 0.30	± 0.15	—	0.15	0.15
Over 50 up to 75	± 0.50	± 0.15	± 0.20	0.15	0.20
Over 75 up to 100	± 0.70	± 0.20	± 0.25	0.20	0.20
Over 100 up to 125	± 0.90	± 0.25	± 0.40	0.30	0.40
Over 125 up to 150	± 1.20	± 0.30	± 0.50	0.40	0.50

*Thickness measurements shall be taken at 10 mm from the edge of the flat section.

†The radii of the arcs of the two concave surfaces shall be approximately equal.

13.5 Cutting tolerances on lengths of bars and flats shall be $\begin{smallmatrix} +20 \\ -0 \end{smallmatrix}$ mm.

14. CALCULATION OF MASS

14.1 The mass of the material shall be calculated on the basis that the steel weighs 7.85 g/cm³.

15. MARKING

15.1 Each bar of over 12 mm diameter or of equivalent cross section shall be stamped with the name or trade-mark of the manufacturer, grade, and the cast number or any other identification mark by which the steel may be traced to the cast from which it has been made. Such marking shall be made at the extreme end of each bar.

15.2 Bars of 12 mm diameter or of equivalent cross section and below shall be bundled as agreed to between the purchaser and the supplier and

a metal tag attached to each bundle shall bear similar markings as described in **15.1**.

15.2.1 The material may also be colour coded in accordance with IS : 2049-1978*.

15.3 The material may also be marked with the Standard Mark.

15.4 The use of the Standard Mark is governed by the provisions of Bureau of Indian Standards Act, 1986 and the Rules and Regulations made thereunder. The details of conditions under which the licence for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

16. SAMPLING

16.1 Sampling for Chemical Analysis — The ladle sample analysis shall be supplied by the manufacturer. If the product analysis is required by the purchaser, at least one product sample shall be taken from each cast.

*Colour code for the identification of wrought steels for general engineering purposes (*first revision*).

(Continued from page 2)

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TO
IS : 3431 - 1982 SPECIFICATION FOR STEEL
FOR THE MANUFACTURE OF VOLUTE, HELICAL AND
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(Second Revision)

(Page 7, clause 7.1.2)—Delete.

(SMDC 5)

TO

IS: 3431-1982 SPECIFICATION FOR STEEL
FOR THE MANUFACTURE OF VOLUTE, HELICAL
AND LAMINATED SPRINGS FOR AUTOMOTIVE
SUSPENSION

(Second Revision)

(Page 6, heading of Table 2, line 3) -
Substitute '(Clauses 6.1 and 9.1)' for 'Clauses
6.1 and 9.2)'.

(Page 7, clause 8.1) - Substitute the
following for the existing clause:

'8.1 The data quoted in col 2 of Table 4 for
hardness in the untreated (hot-rolled) condition
are reference values and are not binding.

(SMDC 5)